REMARKS

Claims 1-5, 7, 8, and 10-14 are pending in the present application. Claims 6 and 9 have previously been canceled.

Personal Interview Summary

Applicants appreciate the courtesies extended to their representative and inventor Harshad Sardesai during the interview conducted on June 3, 2003. During this interview, Applicants' representative, Michael R. Cammarata, and inventor Harshad Sardesai presented various arguments against the Way patent and the Ishikawa patent that were respectively applied and mentioned in the last Office Action.

Messers Cammarata and Sardesai also discussed the specific problem being addressed by the present invention as well as conventional solutions to such problems. In addition, additional arguments discussing four wave mixing and how that is distinct from third and higher order dispersion effects was also presented during this interview. The contents of these arguments are also contained in a Powerpoint presentation a copy of which was left with the Examiner and another copy of which is attached hereto.

Applicants representative then discussed various ways in which the claims could be amended to further define over the art of record. The Examiner Bello tentatively agreed that further defining the

dispersion compensation module as a discrete module, reciting that the first and second compensating fibers are contained within this discrete module, and further defining the intended physical location of the discrete dispersion compensation module would appear to define over the art of record.

Although a final agreement was not reached during the personal interview because an update search must be performed. The Examiner did tentatively agree that such amendments and related arguments would appear to overcome the art of record. This amendment is being filed in compliance with the tentative agreement reached during the personal interview. Therefore, Applicants earnestly solicit the Examiner to reach a final decision, hopefully, one that is consistent with the tentative agreement reached during the interview.

Art Rejections

Claims 1-5, 7-8, and 10-28 are rejected under 35 U.S.C. § 102(a) as being unpatenable over Way (USP 6,366,728). This rejection, insofar as it pertains to the presently pending claims, are respectfully traversed.

First of all and as discussed during the personal interview, the general problem of chromatic dispersion and chromatic dispersion slope are explained. Chromatic dispersion is a common problem in optical transmission systems and is generally measured by a dispersion coefficient (in units of ps/nm/km). Because the dispersion coefficient

varies with wavelength, and because of this variation is generally linear, a second and rather common problem in optical transmission systems is dispersion slope.

This is particularly a problem in wavelength division multiplex (WDM) systems in which a large number of wavelengths are simultaneously transmitted over an optical fiber. The dispersion and dispersion slope problems result in pulse spreading which can ultimately result in a failure to properly receive the optical signals with an acceptable bit error rate. Another problem is the spreading pulses may begin to interfere or otherwise cause inter-symbol interference such that one pulse-spread channel overlaps with another pulse-spread channel thereby causing distortion and bit errors.

The Way patent offers one solution to the dispersion problem as well as the dispersion slope problem. As clearly shown in the front page of the Way patent and as stated in the title of the Way patent, Way discloses a composite transmission line in which different types of optical fibers are spliced together to form the main artery of the communication system.

As discussed during a personal interview and as shown in page 5 of the attachment, Way's composite transmission line is a distributed solution in which the dispersion and dispersion slope compensation are distributed along the transmission line. In other words, the optical signals are dispersion and dispersion slope compensated as they

physically propagate along the composite transmission line connecting the transmitter and receiver.

As the diagram on page 5 in the attachment suggests, the NZDSF (non zero dispersion shifted fiber) and the DCF (dispersion compensating fiber) used by Way are physically part of the transmission line and laid out so that their physical line has a one-to-one correspondence to the physical propagation distance. This is essentially what Applicants mean by a distributed approach.

During the interview, the Examiner also pointed out that Fig. 2 of Way suggests locating the DCF 32 within the receiver/repeater 16 of transmission system 10.

Applicants counter this argument by pointing out that only a single piece of DCF is located within a receiver/repeater as shown in Fig. 2 of Way and that the remainder and overall nature of his approach is still a composite transmission line that operates in a distributed fashion to compensate for dispersion and dispersion slope. As discussed in Way, column 9, lines 40-49:

> In general, However, the goal is to design the composite optical fiber transmission line 12 in such a manner that the residual chromatic dispersion is at or near zero and the residual chromatic dispersion slope is at or near zero. It should be noted that the third fiber, which will preferably be implemented as a DCF, will be implemented as part of the composite optical fiber transmission line 12, as shown in Fig. 1, or provided within or as part of the receiver/repeater 16 of Fig. 1.

Thus, Way clearly discloses that the DCF is part of a composite transmission line only one piece of which may optionally be provided within the receiver/repeater 16. The fact remains, however, that Way at best teaches only a single piece of DCF within a receiver/repeater and that this DCF is considered by Way to be part of the composite optical transmission line.

In sharp contrast, the amended claims clearly define over Way. Specifically, amended apparatus independent claim 1 now recites a discrete dispersion compensation module. Way's composite transmission line is clearly not a discrete dispersion compensation module. In Way's method, some of the dispersion compensation occurs within the DCF fiber 32 which is clearly part of the composite and distributed transmission line. In contrast, as the amended claims clearly state, all of the dispersion and dispersion slope compensation occurs in the discrete dispersion compensation module Even though the DCF 32 may be located within a receiver/repeater as shown in Fig. 2, Way does not disclose a discrete dispersion compensation module that compensates for dispersion slope and dispersion *at a discrete location within the module*. Page 8 of the attachment further illustrates the difference between Way and the present invention. As shown therein, Way's method of a composite transmission line applies to the transmission line segments that connect repeaters (optical line amplifiers). In contrast, the present invention is a discrete module that may be

located at discrete locations in the optical network and not along the transmission line itself as per Way. More specifically, the present invention is located between the multiplexer and demultiplexer of the optical transmission system.

Indeed, the claims have been further amended to define this specific location for the discrete dispersion compensation module which is a location certainly not disclosed or suggested by Way at least because his method is clearly a distributed solution requiring a long length of composite transmission fiber to accomplish dispersion and dispersion slope compensation.

Further distinguishing the invention from Way is the fact that the claimed discrete dispersion compensation module includes at least 2 dispersion compensation fibers therein. At best, Way discloses only a single piece of DCF 32 within a receiver/repeater. As pointed out above, a single piece of DCF is not sufficient to substantially compensate for dispersion and dispersion slope and Way relies upon the entire composite transmission line to compensate for these optical degradation effects. By physically locating 2 dispersion compensation fibers within a discrete module, the invention provides a novel and non-obvious solution that is not taught or suggested by Way.

The present invention's utilization of a discrete module having at least 2 dispersion compensating fibers has distinct advantages over Way. Namely, the present invention is able to compensate for an

installed base of transmission fiber (fiber plant). In general, optical telecommunications equipment must connect with an existing fiber plant wherein optical fiber has already been placed within trenches and conduits and must be used to transmit the optical signals generated and received by the later-installed telecommunications equipment. Such installed fiber plants cannot be removed, replaced or upgraded because of the huge investment and resources to install them in the first place. Typically, an expensive trenching operation must be performed to lay the optical fiber and such trenching and such retrenching should be avoided whenever possible.

The present invention compensates for such installed fiber plants by utilizing a discrete solution that may be connected at any point along the transmission line provided that this location is between the multiplexer and demultiplexer. This location between the multiplexer and demultiplexer is important because the invention compensates for all of the wavelengths simultaneously. Thus, the invention requires that the various optical wavelengths of the WDM system be optically combined before being compensated by the discrete dispersion compensation module.

In contrast, the Way patent is from an inventor employed by MCI Worldcom which is a service provider that itself installs optical fiber plants. Thus, the inventors of MCI Worldcom enjoy the ability to design a composite transmission line for a specific route before the

fibers actually installed. Thus, MCI Worldcom inventors are not faced with the same problems faced by the present inventors who are employed by a telecommunications equipment provider. Such telecommunications equipment providers do not have the luxury of ripping out fiber or installing fiber plants in the first place. MCI Worldcom inventors do and thus they invented a composite transmission line that may be installed as the optical route is installed so that when the equipment is turned on dispersion and dispersion slope compensation are automatically provided by the composite transmission line.

Furthermore, the independent method claim 16 has also been amended to recite a method for compensating dispersion using a discrete dispersion compensation module. Independent claim 16 has further been amended to recite the physical location of the discrete compensation module and the optical coupling step which now recites optically coupling the discrete dispersion compensation module to a transmission path of the optical communication network between a multiplexer and a demultiplexer of the optical communications network. These features clearly distinguish over Way who offers a distributed approach and not a discrete solution. Also distinguishing claim 16 is the provision of 2 dispersion compensation fibers with the discrete dispersion compensation module which is a feature clearly not present or suggested by Way.

For all of the above reasons, taken alone or in combination, Applicants respectfully request reconsideration and withdrawal of the Way rejection.

Additional arguments directed Against Ishikawa

In the response to arguments section of the Final Office Action, Examiner Bello cites Ishikawa as providing a discrete module for dispersion compensation. Fig. 40 of Ishikawa is cited in the Office Action specifically.

In rebuttal, Applicants assert that Ishikawa's dispersion compensation compensates each wavelength separately, if substantial dispersion slope compensation is desired. In other words, Ishikawa is clearly directed to per-wavelength compensation. This is quite clear in Figs. 28, 29 and 30 and further illustrated on page 6 of the attachment, and is also clear from Ishikawa's invention claims. As shown therein, Ishikawa clearly performs per-wavelength compensation. In other words, the optical signal is in a demultiplexed state so that that a single wavelength is individually compensated according to Ishikawa's method. Moreover, Ishikawa's dispersion compensator is located before the multiplexer or after the demultiplexer so that it operates upon demultiplexed optical channels and thereby performs per channel compensation.

Note that in Fig. 27 (corresponding to the inventions tenth embodiment), it would appear that Ishikawa performs dispersion compensation without full demultiplexing and multiplexing, but a closer look at the description reveals that Fig. 27 applies only to single channel systems and therefore does not need multiplexing and subsequent demultiplexing. This is clearly stated by Ishikawa when describing the subsequent embodiment of his invention (the eleventh embodiment). In column 34, lines 30-36 Ishikawa writes, "It is to be noted that, while, in the ninth and tenth embodiments described above, description has been given only of transmission of one signal light wave, in the present embodiment, description will be given of the case wherein signal light waves (wavelengths λ1 to λ4)_ of four channels are wavelength multiplexed and transmitted."

Ishikawa has described some instances where dispersion compensation is performed on sub-groups of channels called channel groups (Fig. 31, 32, and Fig. 33), where the de-multiplexer does not demultiplex down to the single wavelength level, but down to the few wavelength level. By having channel groups, Ishikawa relaxes the requirement of substantial dispersion compensation on all wavelengths, in order to have lesser number of compensation modules. Thus, the claimed invention is not met by Ishikawa.

Ishikawa has further described varies permutations and combinations of his per-wavelength or wavelength group approaches, but

this must be contrasted with the applicants' invention where substantial dispersion and dispersion slope compensation is achieved for all channel wavelengths simultaneously without the need for individual or channel group de-multiplexing.

Applicants further assert that there would be no reason, motivation or suggestion to combine Way with Ishikawa. Way's composite optical transmission line teaches away from discrete solutions by offering a solution that is clearly a distributed solution that relies upon a physically long length of composite transmission lines to compensate for dispersion and dispersion slope. Furthermore, Ishikawa's invention is clearly directed to per-channel wavelength or few channel compensation and is simply not located along the transmission line in a distributed fashion as claimed.. Furthermore, the location of Ishikawa's dispersion compensators is quite distinct from and not combinable with Way's composite transmission line.

Conclusion

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Michael R. Cammarata (Reg. No. 39,491) at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

Attached hereto is a marked-up version of the changes made to the application by this Amendment.

Application No.: 09/844,830

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

Respectfully, submitted,

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Attachments

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

The claims of the invention has been amended as follows:

1. (Amended) A discrete dispersion compensation module for substantially compensating for dispersion and dispersion slope at a discrete location in an optical communications network transmitting signals on multiple wavelengths, the dispersion compensation module comprising:

a first dispersion compensating fiber providing dispersion compensation and dispersion slope compensation at the discrete location, said first dispersion compensating fiber having a first non-zero dispersion coefficient and a first non-zero dispersion slope coefficient;

a second dispersion compensating fiber in optical communication with said first dispersion compensating fiber, said second dispersion compensating fiber having a second non-zero dispersion coefficient and a second non-zero dispersion slope coefficient,

wherein a length of said first dispersion compensating fiber and a length said second dispersion compensating fiber are selected to compensate dispersion and to compensate dispersion slope simultaneously for the multiple wavelengths at a discrete location along a transmission path of the optical communications network ,wherein said first and second dispersion compensating fibers are

contained within the discrete dispersion compensating module that is located at a discrete location along the transmission path and between a multiplexer and a demultiplexer of the optical communications network.

2. (Amended) The discrete dispersion compensation module of claim 1 wherein the first non-zero dispersion coefficient is different from the second non-zero dispersion coefficient.

3. (Amended) The discrete dispersion compensation module of claim 1 wherein the first non-zero dispersion slope coefficient is different from the second non-zero dispersion slope coefficient.

4. (Amended) The discrete dispersion compensation module of claim 1 wherein the transmission path is an inter-network element section of transmission fiber optically coupling the discrete dispersion compensation module and a node of the optical communications network.

5. (Amended) The discrete dispersion compensation module of claim 4 wherein the transmission path includes a component in optical communication with the inter-network element section of transmission fiber.

7. (Amended) The discrete dispersion compensation module of claim 1 wherein the transmission path extends between a first terminal and a second terminal to define a terminal-to-terminal path and the discrete

dispersion compensation module is optically coupled to the second terminal and between the multiplexer and demultiplexer.

8. (Amended) The discrete dispersion compensation module of claim 7 wherein the transmission path includes a component in optical communication with the terminal-to-terminal path.

10. (Amended) The discrete dispersion compensation module of claim 1 wherein the length of first dispersion compensating fiber and the length of second dispersion compensating fiber are selected based on a mathematical solution compensating dispersion in the transmission path and compensating dispersion slope in the transmission path.

11. (Amended) The discrete dispersion compensation module of claim 10 wherein the mathematical solution is represented as:

$$D_{trans} * L_{trans} + D_{dcf1} * L_{dcf1} + D_{dcf2} * L_{dcf2} = 0$$

$$L_{trans} * S_{trans} + L_{dcf1} * S_{dcf1} + L_{dcf2} * S_{dcf2} = 0$$

where D is dispersion coefficient, L is length and S is dispersion slope coefficient.

12. (Amended) The discrete dispersion compensation module of claim 11 wherein the length of first dispersion compensating fiber and the length of second dispersion compensating fiber are selected based on discrete lengths approximating the mathematical solution.

13. (Amended) The discrete dispersion compensation module of claim 10 wherein the mathematical solution compensates for Nth order dispersion effects in the transmission path, where N is greater than 2,

said discrete dispersion compensation module further comprising and containing N dispersion compensating fibers, including said first and second dispersion compensating fibers, in optical communication with each other, each of said N dispersion compensating fiber having a non-zero dispersion coefficient and a non-zero dispersion slope coefficient, wherein respective lengths of said N dispersion compensating fibers are selected to compensate 1^{st} through N^{th} order dispersion effects for the multiple wavelengths in the transmission path.

14. (Amended) The discrete dispersion compensation module of claim 10 wherein the mathematical solution includes a value representing dispersion introduced by components in the transmission path.

15. (Amended) The discrete dispersion compensation module of claim 10 wherein the mathematical solution includes a value representing dispersion slope introduced by components in the transmission path.

16. (Amended) A method for compensating dispersion in an optical communications network transmitting signals on multiple wavelengths using a discrete dispersion compensation module, the method comprising:

providing a first dispersion compensating fiber having a first non-zero dispersion compensation and first non-zero dispersion slope compensation in the discrete dispersion compensation module;

providing a second dispersion compensating fiber having a second non-zero dispersion compensation and second non-zero dispersion slope compensation in the discrete dispersion compensation module; and

optically coupling the discrete dispersion compensation module to a transmission path of the optical communications network between a multiplexer and demultiplexer of the optical communicating network;

said first non-zero dispersion compensation, first non-zero dispersion slope compensation, second non-zero dispersion compensation and second non-zero dispersion slope compensation selected to compensate dispersion and compensate dispersion slope simultaneously for the multiple wavelengths in a transmission path.

19. (Amended) The method of claim 16 wherein the transmission path is an inter-network element section of transmission fiber optically coupling the discrete dispersion compensation module and a node of the optical communications network.

21. (Amended) The method of claim 16 wherein the transmission path extends between a first terminal and a second terminal to define a terminal-to-terminal path, said optically coupling step optically

coupling the dispersion compensation module to the second terminal and between the multiplexer and demultiplexer.

26. (Amended) The method of claim 23 wherein the mathematical solution compensates for Nth order dispersion effects in the transmission path, where N is greater than 2, said providing steps providing N dispersion compensating fibers having non-zero dispersion compensation and non-zero dispersion slope compensation in the discrete dispersion compensation module, wherein the dispersion compensating fibers are selected to compensate 1^{st} through N^{th} order dispersion effects for the multiple wavelengths in the transmission path.